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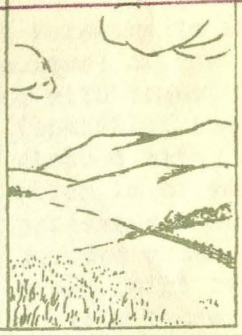

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COLLECTING AND HANDLING OF THE SEEDS OF CALIFORNIA WILD PLANTS

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Not long ago the object of forestry was pretty generally considered to be the growing of timber, and forest planting was concerned almost exclusively with the planting of lumber producing trees. The text-books, it is true, have given increasing attention to the part played by ground-cover vegetation in forest ecology, but these discussions have rarely suggested the actual cultivation of such plants. Gradually, and with rapid acceleration in recent years, the concept of forestry has broadened to keep pace with a growing recognition of the importance of other uses of the forest, such as grazing, recreation, streamflow regulation, erosion control and even the preservation of scenic beauty.

1/ The authors wish to express their gratitude to C. L. Hill of the California Forest and Range Experiment Station for editing this publication.

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Today, in response to these diverse human needs, forestry is in many places as much concerned with the protection and culture of the lesser vegetation, i.e. the shrubs, herbs and grasses as with trees. In the mountains of southern California and the Sierra foothills, for example, millions of acres of watershed are completely clothed with chaparral, a dwarf forest of shrubs and lesser plants, which is of vast importance in controlling runoff and erosion and which possesses also a peculiar scenic charm. The artificial revegetation of denuded areas in this chaparral type, the planting of the bare sides of newly built roads through high forest, the enhancement of camp-grounds and other recreational areas or of forest administrative sites - all may require the use of minor vegetation instead of trees or in combination with them.

Modern silviculture therefore requires a practical knowledge of this minor vegetation, how the various species grow and reproduce in nature, and how they may be reproduced artificially. Are seed crops abundant; is the harvesting simple and cheap or difficult and costly; can the seed be stored or must it be sown at once; will it germinate readily or are special treatments required? Will inexpensive direct sowing be successful? If nursery propagation proves necessary what technique should be followed; can bare-root stock be used or must the plants be tenderly nursed in pots to a suitable size? Answers to such questions must be found for hundreds of native species before they can be successfully and economically used in the new forest management.

The accumulation of such information, even for a single state, is a very slow process. The present publication touches only a small fragment of California flora, dealing with only 255 species. Most of the plants have been selected because of their importance for erosion control work; only a few for their ornamental value. This publication is primarily designed for use in California, but since the general principles of handling the seed of wild plants are the same everywhere, it is hoped that the information here presented may be of some value to persons working in other localities.

Collection

Seeds of a limited number of wild plants can be purchased from commercial seedsmen, but many desirable species are not available from this source. Moreover, since dealers are usually prepared to meet only the demands of amateur gardeners for small packet lots of wild seeds, their supplies are likely to be both inadequate and too costly for large scale operations. In these circumstances the collection of seed by the operator himself may be necessary, and it is chiefly for his guidance in gathering and handling the seed that the present notes are prepared.

One of the most important items in collecting seed is the careful botanical identification of the mother plants. When a trained botanist is in charge of seed collecting, the matter of identification presents no difficulties. On the other hand, when seed harvesting is entrusted to non-technical men, the possibility of mistaking the plants should not be overlooked. Seed harvesting by a special crew, consisting of a botanist and one or two helpers, however, is costly and may usually be employed only for harvesting rare or botanically ambiguous seeds. To make collection by non-technical men safer, it would be advisable to build up a reference collection of authentic fruits and seed samples, under the supervision of a trained botanist. Most seeds can be kept in small size glass vials. Only a few larger seeds, such as acorns or nuts, require larger containers. A seed collection of this kind is often indispensable in establishing identification. A further aid in the collection of uncommon species is the use of small-sized herbarium cards holding the fruiting heads or other showy plant parts in their harvesting aspect. If covered with transparent cellophane such cards can be used in the field without damage.

A simpler way of procuring seed is through the cooperation of national forest or national and state park authorities. In such cases the person in charge of the harvesting crew should be fully instructed in the correct procedure in advance. With a little initial effort this method of seed harvesting is quite satisfactory.

It happens quite often that a desired plant grows in a remote or perhaps not easily accessible place, so that a special trip to that part of the country may be too expensive. The much prized wild lilac, Ceanothus cyaneus, for example, occurs naturally in only a few isolated canyons in San Diego County. Where rare species are concerned, the difficulty can sometimes be overcome by obtaining permission to collect seeds in public or private botanical gardens. Even the back yards of amateur gardeners should not be overlooked as prospective seed gathering grounds. Seeds of the above-mentioned wild lilac, for example, have been collected for several years from a large bush growing near the garage of a private residence. Shade trees of city streets and highways sometimes also afford an opportunity for seed gathering. In California, honey locust seeds have been regularly collected from planted trees along the streets of old mining towns. Elm, maple, and mountain ash have also been collected in this manner.

For certain species, or for continuing projects which require an assured annual supply of seed, it may be expedient to establish a seed farm where desirable plants can be grown and the seed most conveniently gathered. This applies particularly to rare species such as Carpenteria californica, and to plants whose seeds ripen and disperse in a short space of time, as do the lupines. Species having dust-like seed, such as Rhododendron or Philadelphus, also can be grown to special advantage in the seed farm. A single bush of rhododendron in one year would provide seed enough to satisfy the needs of a large nursery for several years. On a small scale this seed farm idea has been used in California with considerable success.

The time for collecting the seed of most species can be stated only in very broad terms. It varies from year to year and from place to place. Seeds of one species may be ready for collection in the southern part of its range while it is still blooming in the northern part. The same is true with the altitudinal distribution of a species. Forecasts of abundant seed crops, as reported by rangers and other field men, are used in many regions. Such forecasts work very well with well-known forest trees, especially where they occur in pure stands and over large areas. When seeds of lesser known species are sought, however, it is unwise to depend on the reports of field men. In California, the task of locating suitable harvest places and times for desirable plants has been in the hands of a trained botanist.

With respect to the technique of seed gathering, each species offers a problem of its own. For example, the gathering of Sambucus berries can be best accomplished in the cluster and with the aid of long-handled pruning shears, while hand snips are required to clip Photinia berries. In stripping a shrub of its fruit, care should be taken to avoid mutilating the plant by breaking tall branches or otherwise disfiguring its appearance for the sake of adding a few fruits out of ordinary reach. Cleaning of the seed should not be attempted in the field, except in the case of large seeds, such as acorns or chestnuts. As a rule, fruits (i.e. pods, capsules or berries) rather than seeds should be gathered. The field equipment needed for seed collection should include:

1. Strong manila envelopes, 4 x 6 inches, with clip fasteners, for small lots of dry fruits and seeds.

2. Five-pound sugar sacks for large lots of dry seeds, and small lots of large or pulpy fruits.

3. Large sugar sacks and gunny sacks for coarse seeds, cones, acorns, etc.

4. Tags of sized linen or tough cardboard for labeling sacked collections.

Every seed lot should be labeled by means of a substantial tag firmly tied to the sack. The label should show the scientific name, lot number, date, place of collection, altitude, name of collector, and weight when collected - all very plainly lettered with a soft (No. 2) lead pencil. A very hard pencil, indelible pencil, or ordinary writing ink, should never be used for the labeling of seed lots. As an extra precaution it is advisable to place a second label, with the same information, inside the sack or envelope. This label should be of good quality paper and should be folded face inward, or, if the seed is damp or pitchy, should be put inside an envelope to protect the essential data. When a collector is uncertain about the identity of the seed parent, it would be advisable to accompany the seed with a specimen of foliage, and flowers if such are still to be found.

In the case of some species favorable seed collecting sites must be located and the desired plants spotted while they are still in bloom and therefore more conspicuous than in their fruiting stage. This is especially important with low annual herbs that are difficult to identify or even to find after the flowering stage.

It is preferable to collect most seeds when they are entirely ripe and dry. Exceptions to this rule are species with pod or capsule fruits that pop open suddenly when ripe and scatter their seeds widely. In this class fall the poppies, some lupines and many of the Ceanothi. The fruits of such plants must be collected while they are still a little green; if left until quite dry the fruits split open at a touch and the seed is lost. In some localities fruits of this type can be collected best in the early morning while the plants are still moist with dew. The proper stage for collecting should be determined by periodic examination of typical fruits. When in case of necessity unripe fruits of species other than the popping types are collected, they should be taken with pieces of stems or twigs attached. Taken in that manner, and not too green, such fruits will usually ripen when spread out in a dry and well ventilated place. Indeed, it is said that the fruits of some plants, such as roses, should be gathered before they are entirely ripe, if quick germination of the seed is desired.

The seed ripening of many plants extends over a period of several weeks, hence if only one collection can be made it should be timed to catch the peak of ripening in order to get the largest harvest of good seed for the labor invested. With poppies, perennial lupines and some shrubs, several collections are almost always necessary.

Extraction

All seeds received at a central station or storehouse should be thoroughly dried before being placed in storage. Exposure to direct sunlight in a well ventilated greenhouse is sufficient to dry most seeds. Fruits of the "pop-open" type previously described should be spread thinly in trays and covered with cheese cloth, fine mesh-wire or paper to prevent loss of seeds. Exposure to sunlight is helpful also in destroying insect larvae which are often gathered with the seed. Only in cases of severe infestation is fumigation of the seed needed. When that becomes necessary good results are obtained by exposing the seeds overnight in an airtight chamber to vapors of a mixture of one part carbon tetrachloride and three parts ethylene dichloride. One ounce of the mixture is sufficient for four cubic feet of air. Seeds enclosed in dry fruits, such as those of Ceanothus, Pentstemon, Fremontodendron, or Castanopsis, should first be run through a fruit disintegrator, or otherwise crushed, and the chaff then removed by means of a seed cleaning machine or by hand screening and winnowing. If the chaff is thoroughly dry it is not altogether necessary to clean the seed, particularly in the case of large seed lots intended for direct sowing on some particular project in which exact quantities of seed need not be known.

Soft fruits, such as those of Prunus or Arbutus, should be fermented in water in a warm place to facilitate removal of the pulp. After the flesh is disintegrated, the seeds are separated from the mash and thoroughly dried. This method of seed cleaning should be used with discretion because the soft seeds of some shrubs, such as Photinia, are easily damaged if the berries are soaked too long.

Germination

Germination tests of seeds should be started as soon as the seeds are gathered. One hundred seeds is the standard number used in the reported California practice. Although germination percentage is indispensable in the determination of seed value, it is often more important in the opinion of the writers, to note the extent to which the seed of each species may be refractory to germination. This information is of greater significance in the search for effective methods of germinating wild plants than is the exact percentage of germination, which usually fluctuates from lot to lot of the same species.

For judging the germinative capacity of the seed of a species, it is not always necessary to carry on complicated germination studies. The taxonomic position of the plant will often give a clue to the germination behavior of its seed. If the plant is a member of the family Leguminosae, for example, it might be assumed that the seed would require the same handling as the majority of seeds within this family, i.e. the hot water treatment. Again, grasses, with few exceptions, do not require any treatment to hasten germination. To be sure, this rule of thumb should be used with caution. For instance, in the genus Cercocarpus, the seeds of Cercocarpus betuloides germinate rather quickly, while those of Cercocarpus ledifolius require pregerminative chilling. More information about the taxonomy and germination of California plants can be found in a previous article by the senior author dealing with the germination of California plants.2/

Determination of the average number of seeds per pound of clean seed is a desirable routine practice. This number, together with the germination percent, is essential in evaluating any seed lot and in determining the amount of seed required for the production of any desired number of plants.

It has been pointed out elsewhere2/ that sterilization of the soil, so frequently used by research workers, is absolutely useless in germination tests. The sterile flats in a greenhouse invariably acquire a full dosage of fungi and bacteria in a short time despite such precautions.

2/ Mirov, N. T. Germination behavior of some California plants. Ecology 17: 4, October 1936, pp. 667-672.

For the germination medium, various materials have been used. In our experiments pure non-alkaline sand has been used when seedlings are to be discarded after the tests, since sand alone contains very little nutrition and cannot support seedlings for a prolonged time. When seedlings are to be preserved for some further purposes the seeds are germinated in light, loamy soil, topped with a thin layer of washed non-alkaline sand as a measure of protection against damping-off. A very satisfactory soil mixture can be prepared by mixing one-third soil, one-third sand and one-third leafmold. If leafmold is not obtainable it may be replaced by peat, but in this case the mixture will have much less fertility.

Large seeds such as walnuts, acorns, hazel nuts or chestnuts are germinated most conveniently in deep boxes filled with peat moss. In most cases the seedlings grown in germination tests need not be discarded for with slight additional effort after the germination test is completed, they can be transplanted into suitable pots or cans and grown to sizes suitable for special plantings.

Storage

Since most wild plants do not produce abundant seed crops every year, the question of seed storage is important. Obviously, it will make the worker independent of the uncertainties of seed years, if he is able to harvest large quantities of seed during bountiful years and keep them in a state of viability until they are needed. The whole question of seed storage is quite complicated and controversial. Some seeds can be stored, for example, in sacks under ordinary temperature conditions, in a well ventilated storage room. Typical of this class are seeds of the woody legumes and cereals. Some of the leguminous seeds, such as acacias, can be stored in this manner for many years. On the other hand, seeds of some conifers are relatively perishable and are better preserved if kept in airtight containers at a temperature of 36-40° F.3/

3/ Mirov, N. T. A note on germination methods for coniferous species. Jour. For. 34:7. July 1936, pp. 719-723.

The following table gives data of some lots of seeds having a direct bearing upon the choice of conditions for the storage of several representative seeds.

Species	Years of storage	Germination percent of seed: Stored at room temperature	Germination percent of seed: Stored at 40° F.
Asclepias mexicana	3	32	96
Castanopsis chrysophylla	3	16	53
Fraxinus oregona	3	10	29
Gaultheria shallon	3	27	73
Pinus contorta	3	85	96
Pinus ponderosa	7	0 4/	29
Pinus jeffreyi	7	38	75
Pinus lambertiana	7	0 4/	95
Garrya elliptica	3	13	8
Myrica californica	3	16	14
Philadelphus lewisii	3	52	39
Pseudotsuga macrocarpa	3	55	53
Picea sitchensis	3	33	13
Shepherdia argentea	3	78	72
Yucca whipplei	3	85	74

4/ This complete lack of germination applies only to the samples used in the tests. It is possible that these species will not always lose their viability under such storage conditions.

From this brief table, which the writers hope to extend, it is seen that in the first eight species cold storage is decidedly beneficial; while the last seven species are either indifferent to the conditions of storage or are even better preserved under ordinary storage conditions. Until similar data become available for other species, the wisest course is to store all received seed in airtight containers and at temperatures between 32° and 40° F. and preferably as close to freezing point as possible.

Treatment of Refractory Seeds

The seeds of many plants germinate readily without the use of any special treatment. To this class belong the seeds of most grass species, those of the sunflower and evening primrose families, and many others. However, some good species require a long time to germinate and this category can be divided into two groups. The first group includes seeds that have a hard impermeable seed coat. The second group embraces seeds whose refractoriness springs from complex physiological causes, concerned chiefly with conditions of the embryo.

Mechanical treatment: In the first group the mere disintegration or rupturing of the seed coat renders the seed germinable. This can be accomplished by various means, including scarification, hot water treatment and the sulfuric acid bath.

Scarification has been widely practiced, for example, with small leguminous seeds such as sweet clover. Among California native plants the clover-like Lotus is one of the very few whose seeds require scarification. When only a small amount of seed is to be scarified, two sheets of sand paper suffice, the seeds being gently rubbed between the sheets. Unfortunately, by this method it is quite difficult to insure uniformity in rupturing the seed-coat. When large quantities of seed are to be scarified, it is advisable to employ a revolving drum filled with sand and driven either by hand or power. A convenient scarifier of this type is described in U.S.D.A. Leaflet 107, November 1934.

The hot water treatment consists in simply soaking the seeds in water hot enough to rupture their seed-coats. The usual method is to place the seeds in a vessel, add three or four times as much hot water (170°-180° F.) as the volume occupied by the seeds, and allow the seeds to stand in this gradually cooling water overnight. By the next morning the seeds will have become swollen with absorbed water and in this condition they should be promptly planted. This treatment will suffice for most hard-coated seeds and the hot water will do them no injury. Indeed, some seeds, e.g. Ceanothus sorediatus, can even be boiled in water for a short time without injury to their embryos.

Acid treatment. Some seeds, e.g. Rhus integrifolia, have seed-coats so tough that more drastic treatment is necessary. Such seed-coats can be disintegrated by treatment with concentrated sulfuric acid (Specific gravity 1.84). Thoroughly dried seeds are put into a heat-resistant jar and covered with the acid, using a volume of acid at least twice the volume occupied by the seeds. The contents should be occasionally stirred until the treatment is completed. (The length of treatment required for different species is indicated in the appendix). When treatment is complete the acid should be carefully decanted and saved for future use. The jar should then be covered with a perforated lid and a good stream of water poured into the jar by means of a rubber tube. It should be mentioned that when water is poured into acid, a violent exothermic reaction takes place. Therefore, large amounts of cold water should be used and, as further safety measure, the jar should be wrapped in a heavy cloth, and the operator should protect his eyes with goggles. After the seeds are given this first rinsing, the jar should be opened and washing soda added at the rate of one table-spoon of soda for every quart of the contents to neutralize the acid, and then left until the bubbling ceases. If the reaction is not complete, more soda should be added. While still in the same jar, the seeds should be washed for two hours with running water. They are then ready for planting.

Physiological treatment. As previously indicated, there is a group of seeds which do not germinate until certain physiological changes inside the seed have occurred. This "after-ripening" or conditioning of the embryo, requires definite combinations of moisture-temperature-time relations which may differ for different species. In nature the required combination may not occur every year. Seeds falling annually may lie dormant for several years only to germinate in great abundance in a season when conditions are just right.

For seeds of this type, stratification has been found to be the best method of inducing germination. It consists of placing the seeds in flats of sand or light soil, and keeping the flats at a temperature of 36-40° F. for various lengths of time. For many species the flats must be held at this temperature for three months, with occasional waterings. Average required periods for other species are indicated in the appendix.

In nursery practice somewhat similar results are achieved with some species by fall sowing in outdoor seedbeds. With outdoor sown seed, whether in nursery or field, it is not the severe winter cold that renders the seed germinable, but rather the temperatures of the spring months fluctuating in the neighborhood of the freezing point. Accordingly, seeds originating in localities which have long severe winters and very short springs, require shorter periods of stratification than seeds from places with milder climates. Finally, it should be understood that stratification is not a "breaking of dormancy" but rather a providing of favorable conditions for the necessary changes in the seed embryo.

APPENDIX

Seed and cultural data for some California plants.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Acer macrophyllum bigleaf maple	Sept.-Oct.	3200	68	90	2 months stratification.
Adenostoma fasciculatum chamise	May-Sept.	413,000	11	75	10% sulfuric acid for 15 minutes.
Adenostoma sparsifolium redshanks	May-June	400,000	33	40	Do.
Aesculus californica California buckeye	Nov.	10	7	75	Germinate in leaf mold or moss.
Agoseris heterophylla	May	722,000	60	17	No treatment needed.
Agoseris retrorsa	May	224,000	36	20	Do.
Agropyron crystatum crested wheat grass	See leaflet 104 USDA	280,000	5	70	No treatment needed. Exotic from Asia.
Agropyron laeve	June-July	72,000	6	89	No treatment needed.
Agropyron saxicola	Aug.-Sept.	454,000	7	55	Do.
Agropyron tenerum slender wheat grass	July	210,000	10	16	Do.
Alnus rhombifolia white alder	May-Oct.	687,000	10	56	Do.
Alnus rubra red alder	May-July	1,087,000	13	14	Do.
Alnus tenuifolia mountain alder	Aug.-Sept.	675,000	9	16	Do.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Alnus viridis var. sinuata thin-leaf alder	Aug.-Sept.	2,021,000	14	12	No treatment needed.
Amorpha californica California indigobush	July-Sept.	38,000	5	42	No treatment needed for fresh seeds. Hot water for stored seed.
Aplopappus bloomeri Bloomer goldenbush	Sept.-Oct.	233,000	21	50	No treatment needed.
Aplopappus ericoides heatherleaf goldenbush	Oct.-Nov.	718,000	5	80	Do
Aplopappus nauseosus rubber goldenbush	Oct.-Nov.	335,000	3	36	Do.
Aplopappus parishii Parish goldenbush	Oct.-Nov.	1,633,000	4	95	Do.
Aplopappus pinifolius pineleaf goldenbush	Oct.-Nov.	1,000,000	4	48	Do.
Aplopappus squarrosus coast goldenbush	Aug.-Oct.	173,000	3	80	Do
Arbutus menziesii Pacific madrone	Oct.-Dec.	2,000 (dry fruits)	103	55	3 mo. stratification.
Arctostaphylos patula greenleaf manzanita	Aug.-Oct.	1,700 (dry fruits)			3 mo. stratification. More easily propagated by cuttings.
Asclepias mexicana narrow-leaf milkweed	Aug.-Oct.	72,000	8	96	No treatment needed.
Aster canescens	June	821,000	6	14	Do.
Astragalus antisellii locoweed	June	183,000	37	23	Do.
Atriplex johnstonii Johnston saltbush	May-July	63,000	14	22	Do.
Atriplex semibaccata Australian saltbush	July-Oct.	75,000	4	64	No treatment needed. Native of Australia.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Azalea occidentalis western azalea	July-Sept.	4,000,000	11	75	Germinate seed in fine peat soil.
Baccharis pilularis kidneywort	Sept.-Nov.	8,200,000	7	92	No treatment needed.
Baccharis viminea mule fat	May	5,000,000	10	75	Easily propagated by stem cuttings in the same manner as willow. Very valuable for erosion control and for low windbreaks.
Bebbia juncea	June	748,000	10	30	No treatment needed.
Beloperone californica	June	47,000	5	96	Do.
Berberis nevinii	June	57,000	95	77	3 mo. stratification.
Betula fontanalis water birch	July-Aug.	4,000,000	33	16	No treatment needed.
Brassica nigra black mustard	June	292,000	3	91	Do.
Brickellia californica	Aug.-Oct.	599,000	3	36	Do.
Brickellia incana	May-June	171,000	33	52	Do.
Bromus carinatus	June	61,000	8	85	Do.
Bromus laevipes	June-July	111,000	16	78	Do.
Calycanthus occidentalis California sweetshrub	Sept.-Oct.	8,000	14	82	Do.
Carpenteria californica carpenteria	Sept.-Oct.	15,020,000	17	80	Do. Careful watering.
Castenopsis chrysophylla golden chinquapin	Sept.	700	24	50	Do. Germinate in peat.
Castanopsis sempervirens Sierra chinquapin	Sept.-Oct.	1,200	16	30	Do.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Ceanothus arboreus tree ceanothus	May-June	50,000	10	87	Hot water.
Ceanothus cordulatus white thorn	July-Sept.	141,000	96	65	Hot water and 3½ months' stratification.
Ceanothus crassifolius heavy leaf ceanothus	May-June	65,000	44	45	Hot water.
Ceanothus cuneatus wedgeleaf ceanothus	April-June	56,000	11	81	Do.
Ceanothus cyaneus	June-Aug.	79,000	94	35	Hot water and 3 mo. stratification.
Ceanothus dentatus cropleaf ceanothus	June-July	95,000	92	88	Do.
Ceanothus divaricatus white bark ceanothus	July-Aug.	73,000	98	45	Do.
Ceanothus diversifolius trailing ceanothus	June-July	84,000	94	61	Do.
Ceanothus foliosus wavyleaf ceanothus	May-July	183,000	12	50	Hot water only or hot water and 3 mo. stratification.
Ceanothus incanus coast white thorn	May-July	92,000	94	88	Hot water and 3 mo. stratification.
Ceanothus integerrimus deerbush	June-July	58,000	94	71	Do. Very important forage plant for deer.
Ceanothus jepsonii musk bush	June-July	43,000	34	35	Hot water. Prefers alkaline soil.
Ceanothus macrocarpus bigpod ceanothus	May-June	15,000	7	90	Do. Ornamental.
Ceanothus oliganthus hairy ceanothus	May-June	73,000	16	62	Do.
Ceanothus papillosus wartleaf ceanothus	May-June	102,000	98	74	Hot water and 3 mo. stratification.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Ceanothus parryi lady-bloom	July	155,000	100	75	Hot water and 3 mo. stratification.
Ceanothus parvifolius littleleaf ceanothus, sweet birch	July	78,000	96	40	Do.
Ceanothus prostratus squawcarpet	July	42,000	92	71	Do. Keep seedlings for the first year in a dry hothouse.
Ceanothus rigidus	May-June	72,000	13	77	Hot water. Rapid growing.
Ceanothus sorediatus jim brush	May-July	122,000	93	100	Boil in water for 5 minutes then stratify for 3 months.
Ceanothus spinosus spiny myrtle	May-June	60,000	98	96	Hot water and 3 mo. stratification.
Ceanothus thyrsiflorus blue-myrtle	April-July	48,000	5	46	Hot water.
Ceanothus velutinus snowbrush	July-Aug.	71,000	100	68	Hot water and 3 mo. stratification.
Ceanothus verrucosus wartystem ceanothus	April-June	72,000	9	72	3 mo. scarification or hot water.
Cercis occidentalis California redbud	Sept.-Feb.	12,000	100	60	Hot water and 3 mo. stratification.
Cercocarpus betuloides birchleaf mountain-mahogany.	June-July	30,000	11	89	No treatment needed. Sow outdoors in fall
Cercocarpus ledifolius curlleaf mountain mahogany	May-June	42,000	163	44	No treatment. Sow outdoors.
Chaenactis artemisiaefolia	June	980,000	95	32	No treatment needed.
Chaenactis glabriuscula	May-June	1,206,000	16	56	Do.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Chenopodium ambrosioides Mexican tea	Sept.-Nov.	5,480,000	17	34	No treatment needed.
Chrysopsis villosa	July-Sept.	403,000	5	14	Do.
Clarkia elegans	May-June	2,225,000	14	30	Do.
Clematis lasiantha pipe-stem	June-Sept.	184,000	37	58	Do.
Clematis ligusticifolia Yerba de Chivato	June-Sept.	93,000	27	21	Do.
Clematis pauciflora Rope vine	May-July	85,000	28	36	Do.
Coreopsis bigelovii	May	310,400	34	5	Do.
Coreopsis douglasii	June	704,500	3	39	Do.
Cornus nuttallii Pacific dogwood	Sept.-Oct.	3,000	71	100	Fresh seed germinate well; treat stored seed with sulfuric acid for 4 hours and stratify for 3 mo.
Corylus californica California hazel	Sept.-Oct.	400	96	20	3 mo. stratification in peat moss.
Crossosoma californicum	May-July	Not known	14	24	No treatment needed. Rare species.
Crotalaria intermedia	Buy seed	87,000	4	54	No treatment for fresh seed. Stratify old seed for 3 mo.
Cryptantha intermedia	Aug.	995,000	8	63	No treatment needed.
Cucurbita foetidissima	June	23,000	8	4	Do.
Cytisus scoparius Scotch broom	July-Sept.	68,000	6	44	Scarification or hot water. Native of Europe.
Dendromecon rigida bush poppy	May-July	50,000	102	21	Alternate daily stratification in 40° F. and 70° F. rooms for 3 mo.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Dicentra chrysantha golden eardrops	May-July	400,000			No results with germination of this species.
Digitalis purpurea foxglove	Aug.	4,000,000	8	66	No treatment needed. Naturalized from Europe.
Diplacus aurantiacus bush monkey-flower	July-Sept.	16,000,000	8	56	No treatment needed.
Diplacus longiflorus	May-July	9,343,000	10	46	Do.
Diplacus parviflorus	June-Aug.	9,500,000	19	82	Do.
Diplacus puniceus rodbush monkey-flower	May-June	13,000,000	14	35	Do.
Elymus condensatus giant rye grass	May-July	25,000	12	22	No treatment needed. Use seed of northern regions. Seed from southern California are usually sterile.
Elymus glaucus	June-Aug.	100,000	6	85	No treatment needed.
Elymus triticoides	June-Sept.	243,000	20	10	Do.
Emmenanthe penduliflora whispering bells	June-July	1,400,000	10	14	Do.
Encelia actoni Acton encelia	May-June	348,000	4	32	Do.
Encelia californica California encelia	May-June	327,000	7	28	Do.
Encelia farinosa white brittlebush	May-July	570,000	7	20	Do.
Epilobium californicum	May-Aug.	1,633,000	4	95	Do.
Eriogonum fasciculatum wild buckwheat	June-Aug.	493,000	6	46	Do.
Eriogonum giganteum	June-July	899,000	4	47	Do.
Eriogonum latifolium	July-Sept.	504,000	7	24	Do.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Eriophyllum confertiflorum golden yarrow	May-Sept.	2,600,000	11	21	No treatment needed.
Erysimum asperum western wall flower	June-Aug.	373,000	7	84	Do.
Eschscholtzia californica California poppy	April-July	540,000	6	49	Do.
Fallugia paradoxa Apache plume	June-July	420,000	7	42	Do.
Festuca megalura	June	857,000	25	15	Do.
Festuca octoflora	May-June	1,724,000	63	24	Do.
Fraxinus dipetala California shrub ash	July-Sept.	8,000	199	56	3 mo. stratification.
Fraxinus oregona Oregon ash	Aug.-Sept.	10,000	99	54	Do.
Fraxinus velutina Arizona ash	May-June	20,000	26	60	Do.
Fremontodendron californicum flannelbush	Aug.-Sept.	15,000	6	50	Hot water; stratification beneficial.
Fremontodendron californicum var. mexicanum	July-Aug.	27,000	66	55	Do.
Garrya buxifolia	Sept.-Oct.	29,000	135	5	3 mo. stratification.
Garrya elliptica silk tassel bush	Oct.-Dec.	18,000	135	53	Do.
Garrya fremontii boar brush	Oct.-Dec.	26,000	107	24	Do.
Gaultheria shallon salal	Aug.-Sept.	5,000,000	27	73	Stratification beneficial but not necessary.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Geranium incisum	Aug.-Sept.		18	80	No treatment needed.
Godetia amoena lilya	July-Sept.	3,400,000	8	80	Do.
Grindelia camporum gumplant	Aug.-Oct.	132,000	3	44	Do.
Hedysarum coronarium French honeysuckle	Aug.	70,000	2	52	Hot water. Introduced from Europe.
Helianthemum scoparium rush-rose	June-Sept.	1,000,000	5	64	No treatment needed.
Helianthus annuus common sunflower	July-Sept.	32,000	4	86	Do.
Helianthus gracilentus slimstem sunflower	July-Sept.	259,000	22	43	Do.
Hemizonia wrightii	Sept.-Oct.	780,000	4	26	Do.
Heracleum lanatum cow parsnip	July-Sept.	76,000	32	39	Do.
Hypericum formosum	July-Sept.	1,916,000	22	50	Do.
Isomeris arborea burro fat	May-July	5,000	6	70	Do.
Juglans californica California walnut	July-Aug.	75	26	35	Germinate in peat moss.
Juglans hindsii California black walnut	Oct. 15-Nov. 30	80	24	28	Do.
Lathyrus sulphureus	July 20-Sept. 1	10,000	12	62	Hot water.
Lathyrus strictus	May-June	6,000	16	49	No treatment needed.
Lepidospartum squamatum broombrush	June 15-Sept. 30	315,000	5	63	Do.
Lespedeza sericea	Buy seeds	210,000	6	63	Native of China. Scarification. Commercial seed is usually scarified.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Lithocarpus densiflora tanoak	Sept. 20-Nov. 1	110	22	78	Germinate in peat.
Lonicera hispidula California honeysuckle	Sept. 15-Oct. 15	27,000	54	20	1 mo. stratification.
Lotus americanus American deervetch	June 1-July 15	113,000	3	90	Scarification
Lotus crassifolius	June 1-July 30	46,000	19	25	Do.
Lotus grandiflorus	June	141,000	9	6	Do.
Lotus strigosus	May	603,000	8	52	Do.
Lotus scoparius broom deervetch	June 1-Aug. 30	436,000	6	54	Do.
Lupinus albicaulis	July 20-Aug. 15	38,000	2	68	Freshly collected seed of the lupines germinates well without treatment. Stored seed requires hot water treatment.
Lupinus andersonii	July 1-Aug. 15	11,000	6	77	
Lupinus arboreus	July-Sept. 30	9,000	2	38	
Lupinus columbianus	July 1-Aug. 30	11,000	3	42	
Lupinus excubitus	June 1-July 30	27,000	6	92	
Lupinus formosus	June	19,000	4	93	
Lupinus hirsutissimus	May	23,900	7	61	
Lupinus latifolius	July 1-Aug. 30	34,600	4	78	
Lupinus longifolius	May 1-June 30	24,000	10	92	
Lupinus stiversii	May 20-July 15	21,000	2	96	

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Lupinus succulentus	May-June	13,000	4	85))	Do.
Lupinus torreyi	July 20-Aug. 30	59,000	2	30)))	
Lupinus truncatus	May	57,000	4	32)	
Lycium richii	June	1,371,000	12	11	No treatment needed.
Madia elegans common madia tarweed	June 1-July 30	159,000	106	87	Do.
Marrubium vulgare horehound	June 1-Oct. 1	462,000	9	52	Do.
Medicago hispida California burclover	May	142,000	7	12	Do.
Melica torreyana	May 1-July 1	249,000	141	46	Do.
Mentzelia laevicaulis blazing star	Aug. 15-Nov. 30	413,000	15	30	Do.
Mesembryanthemum crocceum	June-Aug.	292,000	6	22	Do. Exotic from Africa.
Mimulus cardinalis monkey flower	June-Aug.	22,000,000	16	95	No treatment needed.
Monardella odoratissima	July-Sept.	600,000	29	18	No treatment for fresh seed. Stratify stored seed for 3 mo.
Myrica californica waxmyrtle	Sept. 1-Oct. 1	22,000	113	60	3 mo. stratification.
Nicotiana glauca tree tobacco	June 15-	10,000,000	7	80	No treatment needed. Naturalized from South America
Oenothera hookeri evening primrose	July 1-Aug. 30	1,400,000	11	70	No treatment needed.
Osmaronia cerasiformis	Aug. 1-Sept. 15	1,800	87	100	$2\frac{1}{2}$ mo. stratification.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Paeonia brownii western peony	April 20-June 20	2,000	87	42	2½ mo. stratification.
Parosela schottii	June	13,900	3	99	No treatment needed.
Parkinsonia aculeata horse bean	May-July	12,000	4	100	Not native to California. Boiling water treatment.
Pentstemon antirrhinoides snapdragon pentstemon	May 1-June 15	2,000,000	10	62	No treatment needed.
Pentstemon breviflorus	June 1-Sept. 15	5,000,000	32	21	Do.
Pentstemon centranthifolius	June 15-Sept. 15	255,000	10	52	Do.
Pentstemon deustus	Aug. 1-Sept. 15	496,000	69	100	Do.
Pentstemon heterophyllus	July 1-Sept. 15	1,000,000	10	34	Do.
Pentstemon newberryi	Aug. 1-Sept. 30	1,500,000	59	30	Do.
Pentstemon palmeri	June	294,000	30	62	Do.
Perezia microcephala sacapellote	May 20-June 30	320,000	22	25	Do.
Phacelia californica rock phacelia	June 12-Sept. 30	368,000	143	65	Do. Stratification beneficial.
Phacelia parryi	June	1,468,000	5	44	No treatment needed.
Phacelia tanacetifolia	May-June	450,000	31	7	Do.
Phacelia viscida	June	2,443,000	10	25	Do.
Philadelphus lewisii mock orange, syringa	Sept. 1-Oct. 30	8,000,000	26	52	No treatment needed Stratification beneficial.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Photinia salicifolia Christmasberry, toyon	Oct. 15	24,000	10	73	Fresh seed needs no treatment. Stored seed should be stratified.
Physocarpus capitatus nine-bark	July 1-Sept. 15	822,000	67	9	No treatment needed.
Picris echioides bristly ox-tongue	June 1-Aug. 30	605,000	12	14	Do.
Pistacia chinensis Chinese pistachio	Aug.-Sept.	7,000	13	65	Exotic from China. Fresh seed germinate well. Hot water treatment for stored seed. Stratification.
Platanus racemosa California sycamore	June 10-Sept. 15	219,000	135	12	Stratification.
Potentilla glandulosa	July-Sept.	1,438,000	9	84	No treatment for fresh seed. Stratify stored seed.
Prunus demissa western chokecherry	Aug.-Sept.	1,600	101	12	3 mo. stratification.
Prunus emarginata bitter cherry	Aug.-Sept.	1,800	96	5	Do.
Prunus ilicifolia hollyleaf cherry	Sept.-Oct.	200	52	24	No treatment for fresh seed. Stratify stored seed for 3 mo.
Prunus subcordata Pacific plum	Aug.-Sept.	450	99	100	3 mo. stratification.
Purshia tridentata bitterbrush	July-Sept.	18,000	90	69	Do.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Quercus agrifolia coast live oak	Sept.-Oct.	200	17	73	Oak acorns should be sown in the same fall when collected, and should be stored in a cool room in sacks and frequently inspected. If warm, spread on the floor. Germinate in deep boxes in peat moss or leaf mold.
Quercus chrysolepis canyon live oak	Sept.-Oct.	150	53	56	
Quercus douglasii California blue oak	Aug.-Oct.	180	31	72	
Quercus dumosa California scrub oak	June-Sept.	100	27	80	
Quercus durata leather oak	Aug.-Sept.	100	29	50	
Quercus kelloggii California black oak	Sept.-Oct.	115	15	95	
Quercus lobata valley white oak	Sept.-Oct.	75	41	24	
Quercus wislizenii highland live oak	Sept.-Oct.	100	54	40	
Raphanus sativus wild radish	July-Nov.	54,000	4	96	No treatment needed.
Rhamnus californica California buckthorn	Sept.-Oct.	2,000 dry fruits each containing two seeds.	22	30	No treatment for fresh seed. Stratify stored seed.
Rhamnus crocea red-berry	June-Sept.	70,000	72	60	No treatment needed.
Rhamnus crocea var. ilicifolia hollyleaf buckthorn	June-Sept.	71,000	98	73	Do. No treatment for fresh seed. Stratify stored seed for 3 mo.
Rhamnus purshiana cascara sagrada	Sept.-Oct.	2,000	80	40	3 mo. stratification.
Rhamnus rubra	Aug.-Sept.	3,000 dry fruits each containing two seeds	54	16	Fresh seed germinates fairly well. Stratification improves germination.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Rhododendron californicum coast rhododendron	Aug.-Sept.	2,000,000	13	90	Germinate in fine peat soil.
Rhododendron occidentale western azalea	July-Sept.	4,000,000	11	75	Do.
Rhus integrifolia lemonade berry	July-Oct.	8,000 seeds 3,000 dry fruits	11	84	Sulfuric acid 4 hours or more depending on age of the seed.
Rhus laurina laurel sumac	Aug.-Sept.	90,000	10	32	Hot water.
Rhus ovata sugar sumac	Sept.-Nov.	26,000 seeds or 17,000 dry fruits	18	39	Sulfuric acid 1 to 6 hours depending on age of seed.
Ricinus communis castor bean	Aug.-Nov.	800	4	78	Germinates well. Originally probably from Africa. Locally naturalized in southern California. Beans poisonous.
Robinia pseudoacacia black locust	Aug.-Sept.	20,000	4	80	Hot water.
Romneya coulteri matilija poppy	July-Sept.	600,000	94	20	3 mo. Stratification.
Rosa californica California wild rose	Aug.-Nov.	102,000	104	62	Do.
Rosa gymnocarpa wood rose	Sept.-Oct.	28,000	86	43	Do.
Rosa nutkana	Sept.	30,000	100	50	Do.
Salvia apiana white sage	June-July	341,000	11	71	No treatment needed. Should not be soaked before sowing.
Salvia columbariae chia	May-Aug.	1,000,000	10	28	

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Salvia leucophylla whiteleaf sage	June-July	304,000	5	54)))	Do.
Salvia mellifera black sage	June-July	467,000	38	36))	
Salvia sonomensis creeping sage	Aug.		95	25	3 mo. stratification.
Salvia spathacea	June	27,400	13	26	No treatment needed.
Senecio douglasii creek senecio	June-Oct.	460,000	4	93	Do.
Shepherdia argentea silver buffaloberry	June-Aug.	18,000	38	78	Do.
Sisyrinchium californicum	June	417,000	12	92	Do.
Sitanion jubatum	July-Aug.	64,000	5	90	Do.
Sorbus sitchensis western mountain ash	Sept.	66,400 seeds or 6,210 dry fruits	50	21	4 months' stratification at 32° F.
Spartium junceum Spanish broom	July-Sept.	30,000	54	14	Hot water. Exotic from Europe. Drought resistant.
Sphaeralcea ambigua	June	849,000	18	25	No treatment needed.
Staphylea bolanderi Sierra bladder nut	July-Aug.	13,000	200	16	Sulfuric acid for one hour.
Stenotopsis linearifolius	May-July	233,000	16	24	No treatment needed.
Stipa coronata porcupine grass	May-July	119,000	14	64	Do.
Stipa lettermani	June-Aug.	115,000	14	60	Do.
Stipa pulchra purple needlegrass	May-July	218,000	5	50	Do.

Species	Time of seed collecting	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percent obtained	Treatment and cultural remarks
Styrax californica California snowbell	Aug.-Oct.	1,000 seeds or 500 dry fruits	6	23	
Symphoricarpos albus snowberry	Oct.-Nov.	54,000 seeds or 18,000 dry fruits	(Results		1 hour sulfuric acid, then 6 months' stratification. This valuable erosion control genus can be easily propagated by cuttings under field conditions. Propagation by seed is difficult.
Symphoricarpos mollis	Sept.-Oct.	18,000 dry fruits	are not		
Symphoricarpos rotundifolius	Sept.-Oct.	16,000 dry fruits	conclusive)		
Tanacetum camphoratum	June-Aug.	1,000,000	12	1	No treatment needed.
Tetradymia spinosa	June	120,000	7	2	
Torreya californica California nutmeg	Sept.-Nov.	140	232	92	3 mo. stratification.
Umbellularia californica California laurel	Oct.-Dec.	300	93	41	Do. Fresh seed germinates fairly well in peat moss.
Uropappus linearifolius	May	216,000	35	71	No treatment needed.
Vaccinium ovatum box blueberry	Aug.-Sept.	8,000	91	18	3 mo. stratification.
Vitis californica California grape	Sept.-Oct.	11,000 seeds 3,500 dry fruits	20	74	No treatment needed.
Wyethia helenioides	Aug.-Sept.	10,000	27	36	Do.
Wyethia mollis wooly mule-ears	Sept.-Oct.	25,000	34	16	Do.
Yucca whipplei chaparral yucca	June-Sept.	27,000	9	85	Do.
Zauschneria californica Mexican balsamea	Sept.-Nov.	1,000,000	5	68	No treatment needed.